observing the initial and the later phases of phosphorescence there would be an actual discontinuity between the processes referred to above and those in the curves for the phosphorescence of slow decay.

Summary.—(1) The regions of selective excitation (the bands of excitation) for the Lenard and Klatt sulphides are shown to coincide in position and extent with absorption bands in the transmission spectrum of the substances.

(2) The spectrum of the phosphorescent light during the first few thousandths of a second after the close of excitation, contains one or more groups of over-lapping bands the crests of each group forming a spectral series having a constant frequency interval.

(3) The decay of phosphorescence during the first three hundredths of a second after the close of excitation may be described as consisting of two processes each showing a linear relation between $I^{-\frac{1}{2}}$ and time. The first and more rapid process lasts for less than 0.01 second for the three sulphides studied under the intensity of excitation employed. The second process probably persists for 0.06 seconds or more.

(4) The phosphorescence of long duration of the sulphides under consideration is probably due to another group of bands of comparatively feeble initial brightness which come under observation only after the phosphorescence of short duration has vanished.

[1] The investigation was carried out in part with apparatus purchased by aid of a grant from the Carnegie Institution of Washington.

[2] Lenard and Klatt, *Ann. Physik, Leipzig*, (Ser. 4), **15**, 1904, (225).

[3] Lenard, *Ibid.*, **31**, 1910, (641).

[4] Becquerel, E., *La Lumière*, Vol. 1, 1861.

[5] Nichols, *Philadelphia, Proc. Amer. Phil. Soc.*, **55**, 1916, (494).

[6] Henri, V., *Physik. Zs., Leipzig*, **14**, 1913, (516).

[7] Howe, *Physical Rev., Ithaca*, (Ser. 2), **8**, 1916, (637).

[8] Nichols and Merritt, *Washington, Carnegie Inst., Pub.*, No. 152, (84).

[9] Nichols, these PROCEEDINGS, **2**, 1916, (328).

THE REACTIONS OF THE MELANOPHORES OF THE HORNED TOAD

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The reactions of the melanophores of the horned toad Phrynosoma cornutum are of three distinct types: (1) Those which manifest themselves in a daily rhythm of reactions, correlated with definitely changing

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conditions of illumination and temperature; (2) those which result in an approximation of the color of the skin to that of the substratum on which the lizards live; and (3) those occurring during nervous excitement.

The daily rhythm of melanophore reactions consists in an expansion of the melanphore pigment, and a consequent darkening of the skin, in the morning and afternoon, and a contraction of the melanophore pigment and a paling of the skin at mid-day and at night. These reactions are due to the interaction of illumination and temperature upon the pigment cells. At mean temperatures (20°C. to 30°C.) the melanophore pigment is expanded in the light and contracted in the dark. In this way the coloration of the skin in the morning, afternoon, and night is explained. At higher temperatures the melanophore pigment is contracted irrespective of illumination; the pale coloration of the skin at mid-day is thus explained. At lower temperatures the melanophore pigment is expanded irrespective of illumination.

The responses of the melanophores to illumination and temperature are due to the direct action of these stimuli upon the pigment cells or some closely associated tissue, for: (1) a local illumination, a local shadow, or a local heating of the skin produces a local reaction of the melanophores; (2) the reactions to illumination and temperature take their normal course in regions of the skin which have been isolated from the nervous system.

The adaptive reactions of the melanophores are initiated by stimuli received through the eyes. If horned toads are blindfolded, no adaptive reactions take place. This inhibition of the reaction is not due to the mechanical effects of blindfolding. Upon the adaptive reactions are superimposed the daily rhythm of color changes, with the result that lizards adapted to a dark substratum become paler at night and at mid-day, while lizards adapted to a light-colored substratum become darker in the morning and afternoon.

During states of nervous excitement the melanophore pigment of the horned toad is so contracted that the color of the skin becomes pale. This reaction is brought about by any noxious stimulus, such as prolonged mechanical or faradic stimulation, holding an animal on its back, or prying open its mouth. The reaction occurs irrespective of illumination, temperature, or the adaptive condition of the skin. The coördinative mechanism, by which a local noxious stimulus brings about a reaction of the melanophores of the entire body is described in the following paper. Probably this mechanism also carries out the adaptive reactions of the melanophores.